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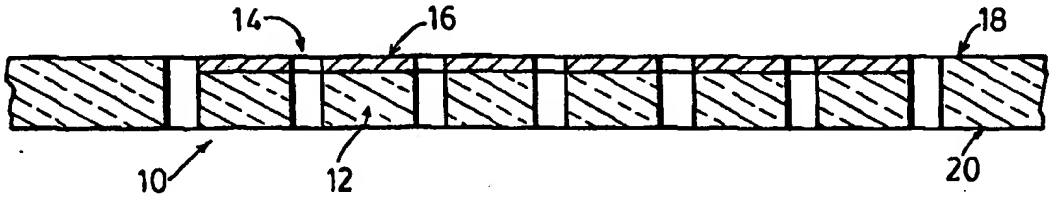
(54) Title: PERFORATED PROTECTIVE PLASTIC FILMS OR SHEETS



(57) Abstract

The invention relates to a protective plastic film or sheet for use in protecting against smoke, heat, corrosive liquids and other hazardous elements. The sheet comprises a fire resistant substrate layer having a primary surface, a layer of titanium covering a major portion of the primary surface of the substrate layer, and a plurality of perforations extending through the polyimide and titanium layers. The perforations allow passage of moisture vapor while the film or sheet provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements. Also disclosed is equipment for use by emergency personnel made from such plastic films or sheets.

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TITLE
PERFORATED PROTECTIVE PLASTIC FILMS OR SHEETS

This application claims priority from United States provisional application serial no. 60/128,927 filed April 13, 1999.

Field of the Invention:

This invention relates to perforated protective plastic films or sheets, and it particular, to protective films or sheets for protecting individuals from smoke, heat, open flame, corrosive chemicals, etc. in the cases of emergency.

Background of the Invention:

It is known to provide suits or hoods made of protective material for use by firefighters and other emergency crews to protect them against the effect of smoke, heat, corrosive chemicals, etc. Such protective equipment is typically made of heat resistant fibers. Sometimes, the fibers are coated with a metal layer, metallized ink or metal filled polymer to reflect thermal radiation and reduce heat absorption. Such coatings may include gold, silver or aluminum. However, it has been found that these metal coatings tend to be dislodged from the underlying fabric. Also, corrosive gases or liquids may attack these metal coatings, thus losing their protective properties. As well, some fabrics cannot be provided with a uniform coating of metal. Moreover, metal coatings tend to be very heavy, and they are impervious to water vapour and do not "breathe".

Canadian Patent No. 1333950 discloses a fire and smoke protective hood and also garments and shields that comprise a high temperature resistant plastic material having a layer of titanium. The plastic material is preferably a polyimide, for example Kapton (a trade-mark). The layer of titanium is preferably sufficiently thick to provide the required heat reflection and transmission properties. The titanium may be a layer of several hundred angstroms thick, for example, from 100 to 1000 angstroms thick.

One major problem with the protective garments of Canadian Patent No. 1333950, and also others in the prior art, is that the garments do not "breathe". That is, the garment does not allow water vapor from perspiration to escape. Thus, if the material disclosed in Canadian Patent No. 1333950 were used in making firefighting equipment (such as

bunker gear and proximity suits), there would be physiological problems associated with such equipment. These problems include heat stress, muscle fatigue and dehydration due to the non-breathability of the equipment. Fully encapsulated bunker gear offers protection, but at a price to the firefighter. Studies have shown that firefighter injury rates increase with fatigue, a phenomenon that usually occurs in the post-extinguishment phase (known as the overhaul stage in fire department operations).

Moreover, bunker gear made with the material of the prior art is both heavy and bulky. A firefighter requires a lot of mobility and flexibility while performing operations at fires, accidents and other emergency operations. It is desirable, therefore, to provide equipment that is relatively lightweight, but that also provides the necessary protection and breathability.

These problems are addressed and reduced by the present invention. Accordingly, it is an object of one aspect of the present invention to provide a perforated protective plastic film or sheet that "breathes".

It is another object of another aspect of the present invention to provide equipment for firefighters and other emergency personnel that protects the user from smoke, heat, corrosive chemicals, etc. while allowing for "breathability".

Summary of the Invention:

Accordingly, in one aspect of the present invention, there is provided a protective plastic film or sheet for use in protecting against smoke, heat, corrosive liquids and other hazardous elements, comprising:

a fire resistant substrate layer having a primary surface;

a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and

a plurality of perforations extending through the polyimide and titanium layers,

whereby the perforations allow passage of moisture vapor while the film or sheet

provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.

In a second aspect of the present invention, there is provided emergency equipment for use by firefighters or other emergency personnel to protect against smoke, heat, corrosive liquids and other hazardous elements, the emergency equipment comprising a protective film or sheet comprising:

a fire resistant substrate layer having a primary surface;

a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and

a plurality of perforations extending through the polyimide and titanium layers,

whereby the perforations allow passage of moisture vapor while the emergency equipment provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.

Brief Description of the Drawings:

The preferred embodiments of the present invention will be described with reference to the accompanying drawings in which like numerals refer to the same parts in the several views and in which:

Fig. 1 is a partial cross-sectional view of one embodiment of a film or sheet of the present invention;

Fig. 2 is a partial view of a film or sheet of Fig. 1 coated on one side with a layer of permeable fabric;

Fig. 3 is a partial view of a film or sheet of Fig. 1 coated on another side with a layer of permeable fabric; and

Fig. 4 is a partial view of a film or sheet of Fig. 1 coated on both sides with a layer of permeable fabric.

Detailed Description of the Preferred Embodiments:

The present invention will be described with reference to its preferred embodiments.

In the preferred embodiments of the present invention, perforated plastic films or sheets are provided for making fire protective equipment or other emergency equipment that allow for "breathability". As illustrated in Fig. 1, the perforated films or sheets 10 comprise a heat resistant plastic substrate layer 12 perforated with holes 14 of sufficient size to allow water vapor to pass through the perforations 14, but of small enough size to prevent liquids such as water or corrosive chemicals to pass through the perforations 14. The films or sheets 10 retain the protective properties of the prior art films by being substantially impermeable to liquids; however, they allow water vapor to escape there through. Further, the films or sheets 10 may preferably be coated with a layer of titanium 16 to make the films or sheets 10 more resistant to heat, smoke, corrosive chemicals, etc.

The perforations 14 make the films or sheets 10 more breathable therefore allowing the users, such as firefighters and other emergency personnel, to carry out their duties without risk of encountering the problems faced with the protective material of the prior art.

The perforations 14 may be made by any known means such as, but not limited to, mechanical perforating devices, electrostatic discharge, laser impingement, etc. These perforations 14 can range in diameter from fractions of a micron to tens of microns. Smaller perforations provide maximum protection to the user from harmful gases and liquids while still allowing the escape or release of water vapor through the perforations 14. Preferably, the perforations 14 should extend completely through the various layers of the films or sheets 10.

One method for cutting such small perforations is described in U.S. Patent Nos. 4,488,030 and 4,777,338, which are both incorporated herein by reference. An apparatus is described in those two patents that involves the discharge of electrical energy stored in capacitors through electrodes on opposite sides of the polymer fiber.

Another method of cutting perforations is described in United States Patent No. 5550346, which is incorporated herein by reference. An apparatus is described that uses a laser beam to cut perforations in sheet material. The apparatus allows for a predetermined

pattern of perforations to be cut in the sheet material. The apparatus and method of United States Patent No. 5550346 may be used advantageously to cut perforations 14 in the films or sheets 10 of the present invention.

The substrate plastic layer 12 of the film or sheet 10 preferably has a thickness between 25 and 75 microns. The layer 12 is preferably made from, but not limited to, a thermoset plastics material such as a heat and chemical resistant polyimide film (such as Kapton® polyimide available from E.I. du Pont of Wilmington Delaware). This layer 12 acts as the substrate for the titanium layer 16. Moreover, Kapton® polyimide, and other polyimide films provide additional thermal, burn-through, chemical (gas and liquid), pathogen and electrical resistance to the film or sheet 10. Also, the polyimide layer 12 allows the titanium coating 16 to be applied with maximum reflectivity, unlike the case found with other substrate fabrics that allow only a discontinuous coating of titanium to be placed on them.

The titanium layer 16 can be applied to one or both surfaces 18 and 20 of the plastic layer 12. In Fig. 1, the titanium layer 16 is illustrated as covering a major portion of one surface 18 only, but the present invention is not limited in such a way. The titanium layer 16 may be applied to both surfaces 18 and 20 of the plastic layer 12 by various known processes such as, but not restricted to, "sputtering", "vacuum metallization', and lamination. The titanium layer 16 may be applied in thicknesses ranging from 100 to 1000 angstroms, although it will be understood that useful thicknesses may not necessarily be restricted to this range so long as the titanium layer 16 provides the desired protection.

Some of the desired properties of the titanium layer 16 include, but are not restricted to the following:

- the titanium layer 16 reflects radiant heat whether the titanium is coated as a layer on the plastic layer 12 or whether it is buried or embedded into the construction of the plastic layer 12;

- the titanium layer 16 is heat resistant at temperatures at or above those encountered in firefighting and other emergency situations; and

- the titanium layer 16 is resistant to many corrosive liquids and gases thereby maintaining its integrity as a reflective layer when exposed to such environments, unlike the case with aluminum and other metals commonly used to metallize plastics.

The titanium layer 16 may be coated onto one or both surfaces of the plastic layer 12, or alternatively, it may be embedded within the structure of the plastic layer 12. Further, the titanium layer 16 may only be coated or embedded on a portion of the plastic layer 12, but preferably, the whole surface of the plastic layer 12 is coated with a titanium layer 16.

The perforated titanium coated plastic film or sheet 10 may be used with or without an additional layer of fabric 21 applied to either the titanium layer 16 or to surface 20 of the plastic layer 12. The titanium layer 16 and/or the plastic layer 12 may also be coated with or laminated to a permeable fabric layer 21 as shown in Figures 2, 3 and 4. In the embodiment of Fig. 2, the permeable fabric layer 21 is coated over the titanium layer 16, whereas in the embodiment of Fig. 3, the fabric layer 21 is coated on the plastic layer 12. As for the embodiment of Fig. 4, the film or sheet comprises two permeable fabric layers 21 and 21a; one fabric layer 21 on the titanium layer 16 and another fabric layer 21a on the plastic layer 12.

Common fabrics that may be additionally used include, but are not limited to aramids (such as Nomex® available from E.I. du Pont of Wilmington Delaware) that provides additional resistance to conductive and convective heat transfer and also functions to provide additional tear and puncture resistance to the overall film or sheet 10.

The combination of the attributes of the perforated titanium coated film or sheet 10 of the present invention and the optional fibrous backing material allows the use of lighter weight insulation in the final equipment while providing significantly improved levels of protection for the user. The microscopic perforations 14 allow the escape of moisture vapor from inside the equipment while providing protection against exposure to smoke, heat, corrosive chemicals etc. encountered in fires and other emergency situations.

Although the present invention has been shown and described with respect to its preferred embodiments, it will be understood by those skilled in the art that other changes,

modifications, additions and omissions may be made without departing from the substance and the scope of the present invention as defined by the attached claims.

What is Claimed is:

1. A protective plastic film or sheet for use in protecting against smoke, heat, corrosive liquids and other hazardous elements, comprising:

   a. a fire resistant substrate layer having a primary surface;

   b. a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and

   c. a plurality of perforations extending through the polyimide and titanium layers,

   whereby the perforations allow passage of moisture vapor while the film or sheet provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.

2. The protective film or sheet of claim 1, whereby the titanium layer covers the entirety of the primary surface.

3. The protective film or sheet of claim 1, comprising a second layer of titanium covering a major portion of a second surface of the substrate layer, and the perforations also extend through the second layer of titanium.

4. The protective film or sheet of claim 1, wherein the titanium layer has a thickness between about 100 to 1000 angstroms.

5. The protective film or sheet of claim 1, whereby the substrate layer comprises a thermoset plastics material.

6. The protective film or sheet of claim 5, whereby the substrate layer comprises a polyimide.

7. The protective film or sheet of claim 1, further comprising an additional layer permeable fibrous backing material.

8. The protective film or sheet of claim 1, whereby the perforations have diameters in the range of about 0.1 to 10 microns.

9. The protective film or sheet of claim 1, whereby the substrate has a thickness in the range of about 25 to 75 microns.

10. Emergency equipment for use by firefighters or other emergency personnel to protect against smoke, heat, corrosive liquids and other hazardous elements, the emergency equipment comprising a protective film or sheet comprising:

a. a fire resistant substrate layer having a primary surface;

b. a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and

c. a plurality of perforations extending through the polyimide and titanium layers,

whereby the perforations allow passage of moisture vapor while the emergency equipment provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.

11. The emergency equipment of claim 10, whereby the titanium layer covers the entirety of the primary surface.

12. The emergency equipment of claim 10, comprising a second layer of titanium covering a major portion of a second surface of the substrate layer, and the perforations also extend through the second layer of titanium.

13. The emergency equipment of claim 10, wherein the titanium layer has a thickness between about 100 to 1000 angstroms.

14. The emergency equipment of claim 10, whereby the substrate layer comprises a thermoset plastics material.

15. The emergency equipment of claim 14, whereby the substrate layer comprises a polyimide.

16. The emergency equipment of claim 10, further comprising an additional layer fibrous backing material and the perforations also extend through the fibrous backing material.

17. The emergency equipment of claim 10, whereby the perforations have diameters in the range of about 0.1 to 10 microns.

18. The emergency equipment of claim 10, whereby the substrate has a thickness in the range of about 25 to 75 microns.

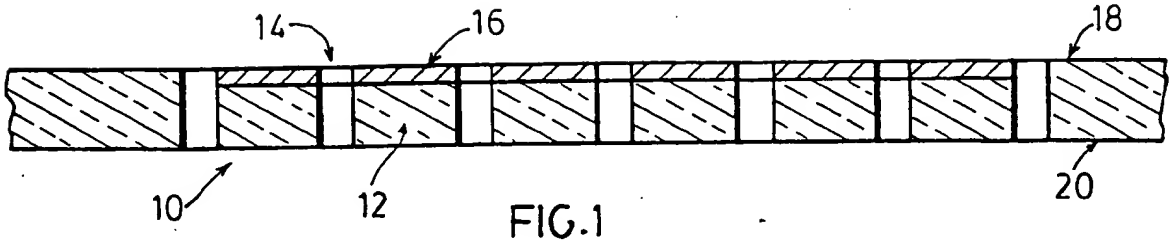

FIG.1

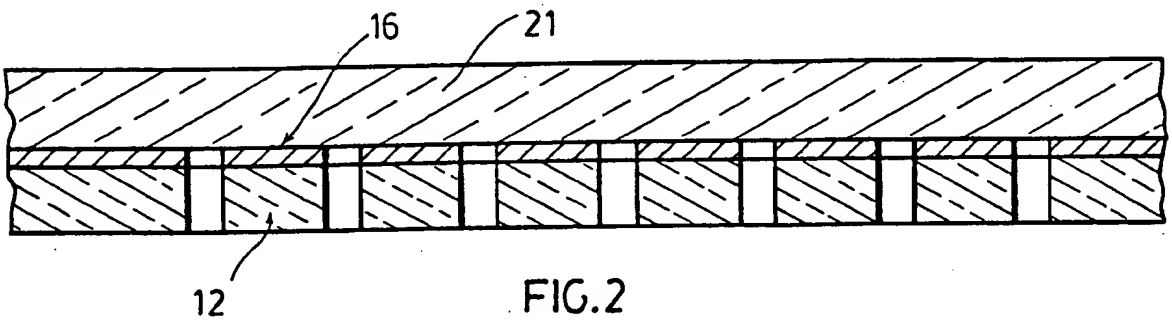

FIG.2

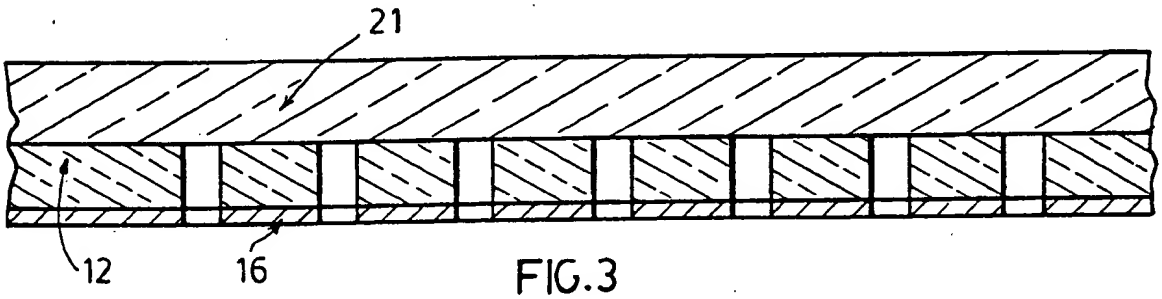

FIG.3

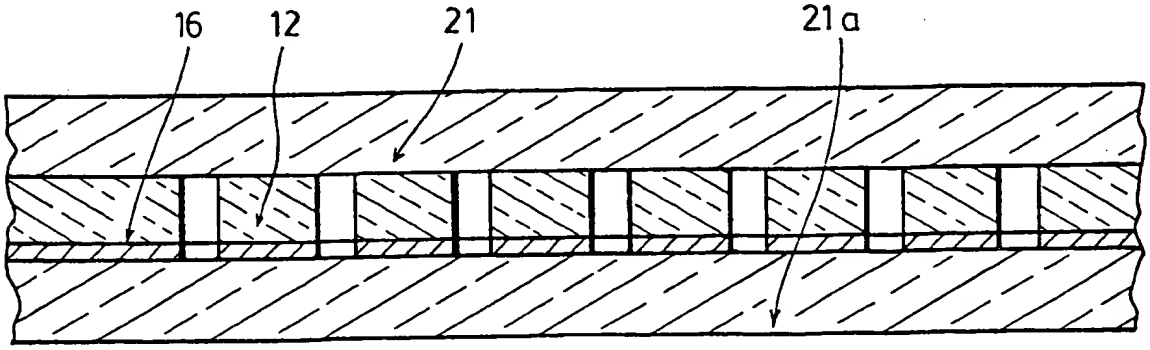

FIG.4

INTERNATIONAL SEARCH REPORT

Int. .ional Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A62D5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A62D A62B A41D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 348 052 A (BRITISH PETROLEUM CO PLC) 27 December 1989 (1989-12-27) cited in the application page 2, line 12-38; claims	1-18
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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